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# DEVELOPMENT OF AN EJECTION SEAT BALLAST BLOCK FOR THE S-3A AIRCRAFT

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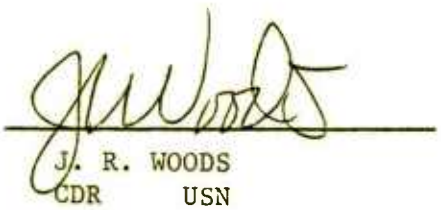
APPROVED BY:  DATE: 11/30/81

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The purpose of this Ballast Block is to ballast an unoccupied ejection seat in the S-3A aircraft. The block adjusts the mass of the seat and the center of gravity to fall within acceptable limits to prevent rapid seat acceleration and tumbling both of which might cause interference with an ejected occupied seat.

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This report describes the development of a ballast block to be used in an unoccupied ejection seat of the S-3A aircraft. Two prototypes were designed and fabricated. The second prototype is an interconnected assembly of four plates which can be assembled or disassembled by one man in less than two minutes. It appears to meet the requirements of low cost, east of handling, and low maintenance.

## I N T R O D U C T I O N

The S-3A aircraft is equipped with a four man ejection system. It provides the pilot and copilot with the capability of command ejection (entire crew) or individual crew member ejection. When all four seats are ejected with one or more of the seats unoccupied a potential for seat collision is present unless the unoccupied seats are properly ballasted. Anthropomorphic dummies are currently being utilized for this purpose, but they are impractical due to expense, handling and storage problems.

NAVAIR (Code 5312A) tasked the Naval Air Development Center to design a low cost, low maintenance ballast block to be used in the unoccupied S-3A ejection seats to replace the anthropomorphic dummies.

## D I S C U S S I O N

Two different prototypes of ballast blocks were designed and fabricated at the Naval Air Development Center. The first prototype as shown in figures 1 & 2 was made of interlocking aluminum cylinders and tubes. Although its center of gravity was matched to that of a fifty percentile aircrewman, it was impractical to match up the moments of inertia because the block would have become too awkward to handle.

In order to allow the cylinders to slide easily into each other during assembly, a liberal clearance was needed. Unfortunately, this made the entire assembly unstable unless several locking pins were used. In addition, the block was found to be too awkward to assemble on the ejection seat, so this design was rejected.

The second prototype shown in figures 3, 4, 5, 6, 7 was designed to be easily handled and to have an overall seat/block center of gravity that would fall on the rocket thrust centerline as shown in figure 8.

It should be noted that the block's center of gravity is not the same as that of a fifty percentile aircrewman and therefore it should only be used in the ESCAPAC ejection seat of the S-3A aircraft.

The ESCAPAC 1E1 ejection seat is equipped with a vernier rocket which can maintain a reasonable stable pitch control even if the seat/block center of gravity has a 2 inch (5 cm) eccentricity with the seat rocket thrust line.

A wooden mock-up of the second prototype was constructed to determine the location of attachment fittings, and to determine handling and maintenance problems. This mockup has been sent to the Naval Air Test Center for evaluation of safety, and to determine the best way to tie down the block inside the aircraft when it is not being used on the ejection seat.

The second prototype block is an assembly of four (4) 45 pound (20.5 Kg) steel plates which are to be cadmium plated and painted black. Each plate has a hand grip machined into it. The base plate has an 8.4 inch (21.3 cm) high post upon which the other three plates are slid. A quick disconnect pin on the top plate is used to lock all four plates together. If the post welded onto the base plate offers interference when it is carried onto the aircraft, then it can be attached to the base plate with a hinge so it will fold flat. The ballast block plates can easily be carried into the aircraft and assembled or disassembled by one man in less than two minutes.

Four male Koch quick release adapter fittings are mounted onto the top plate. These connect to the two parachute riser lines and to the two RSSK kit fittings.

After the four plates are assembled onto the ejection seat the adjustable straps should be tightened and the inertia reel should be locked by placing the inertia reel handle in its manually locked position.

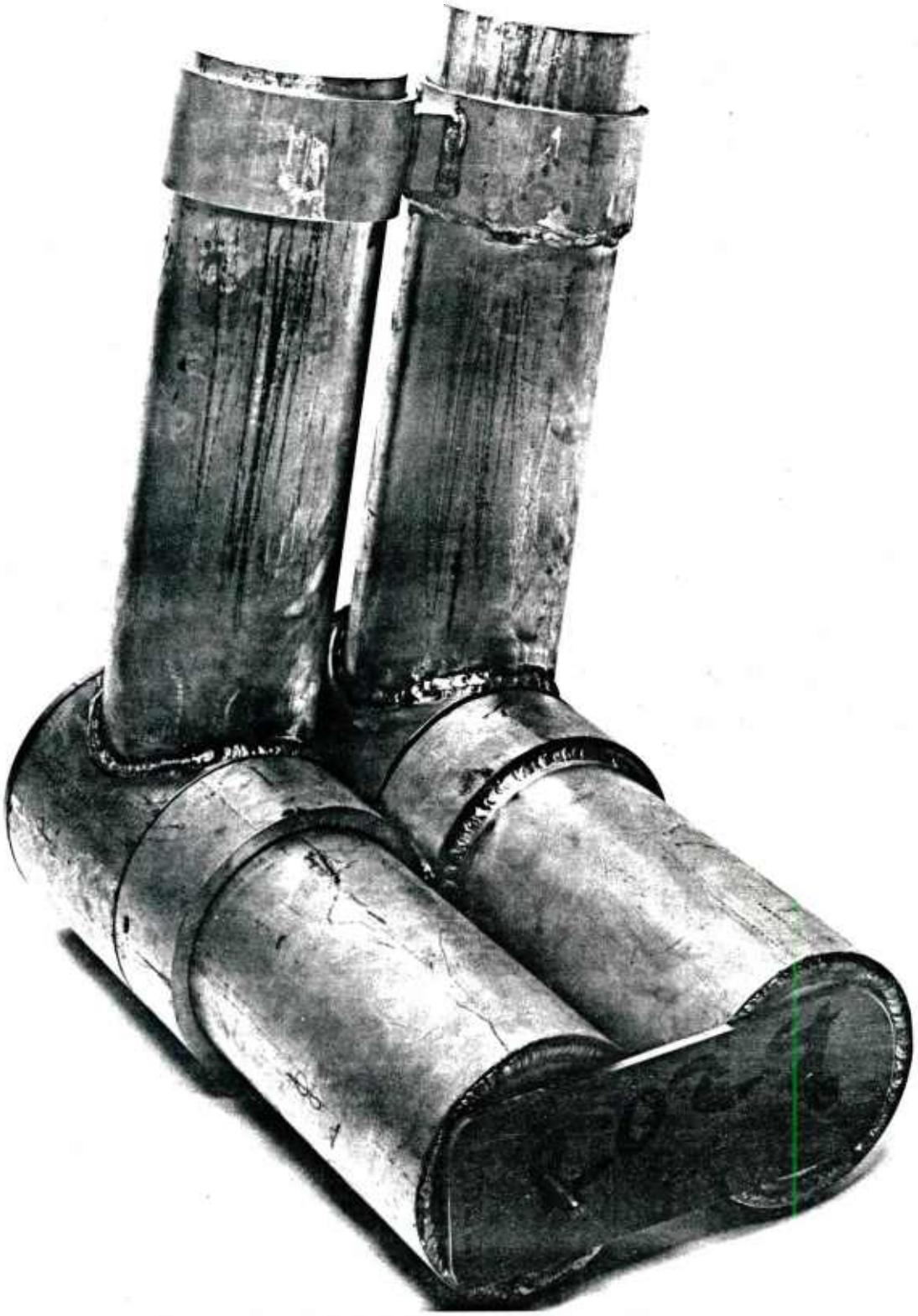


Figure 1 - Mod 0 Ballast Block Assembled

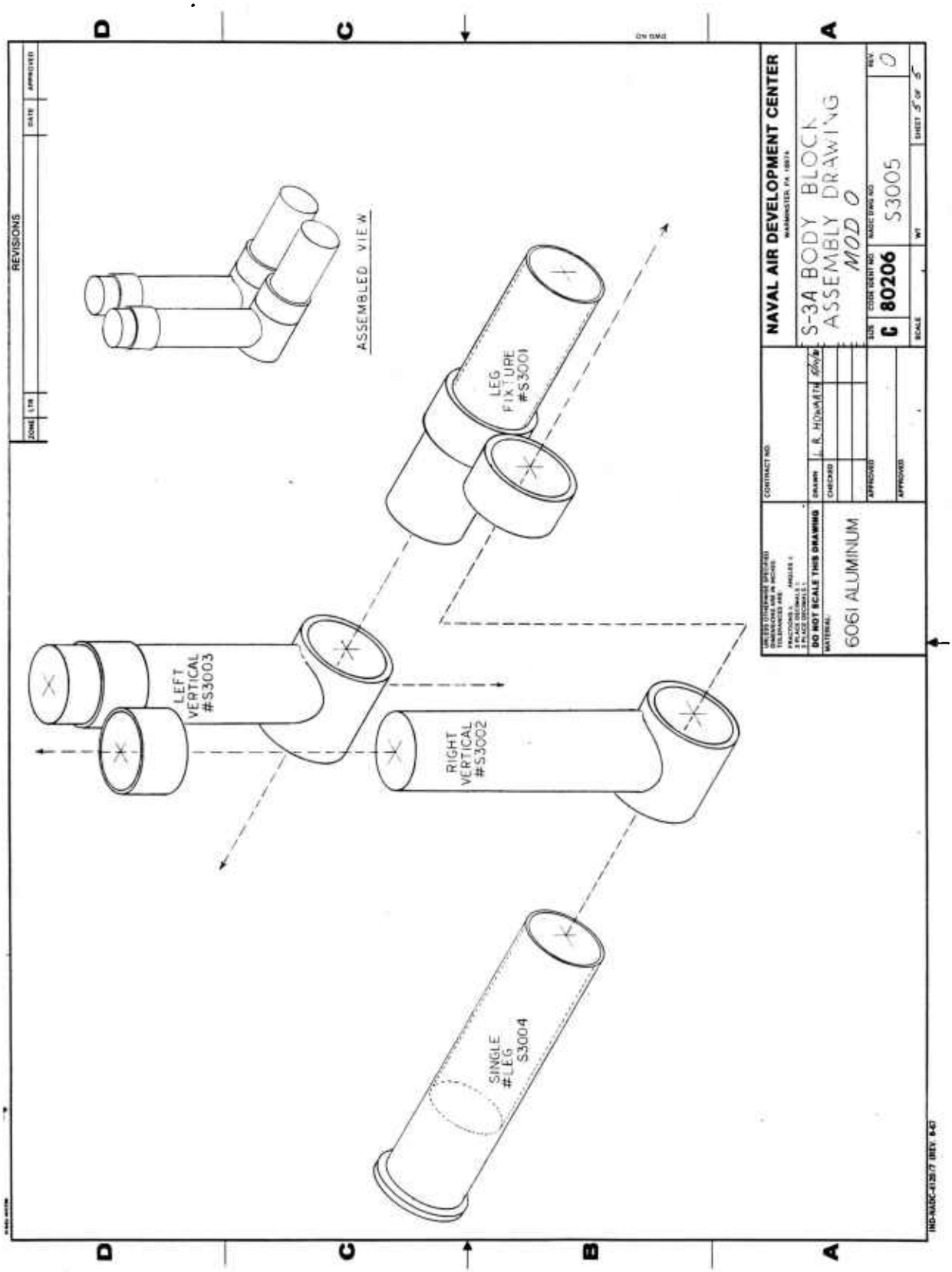



Figure 2 - S-3A Body Block Assembly Drawing Mod 0

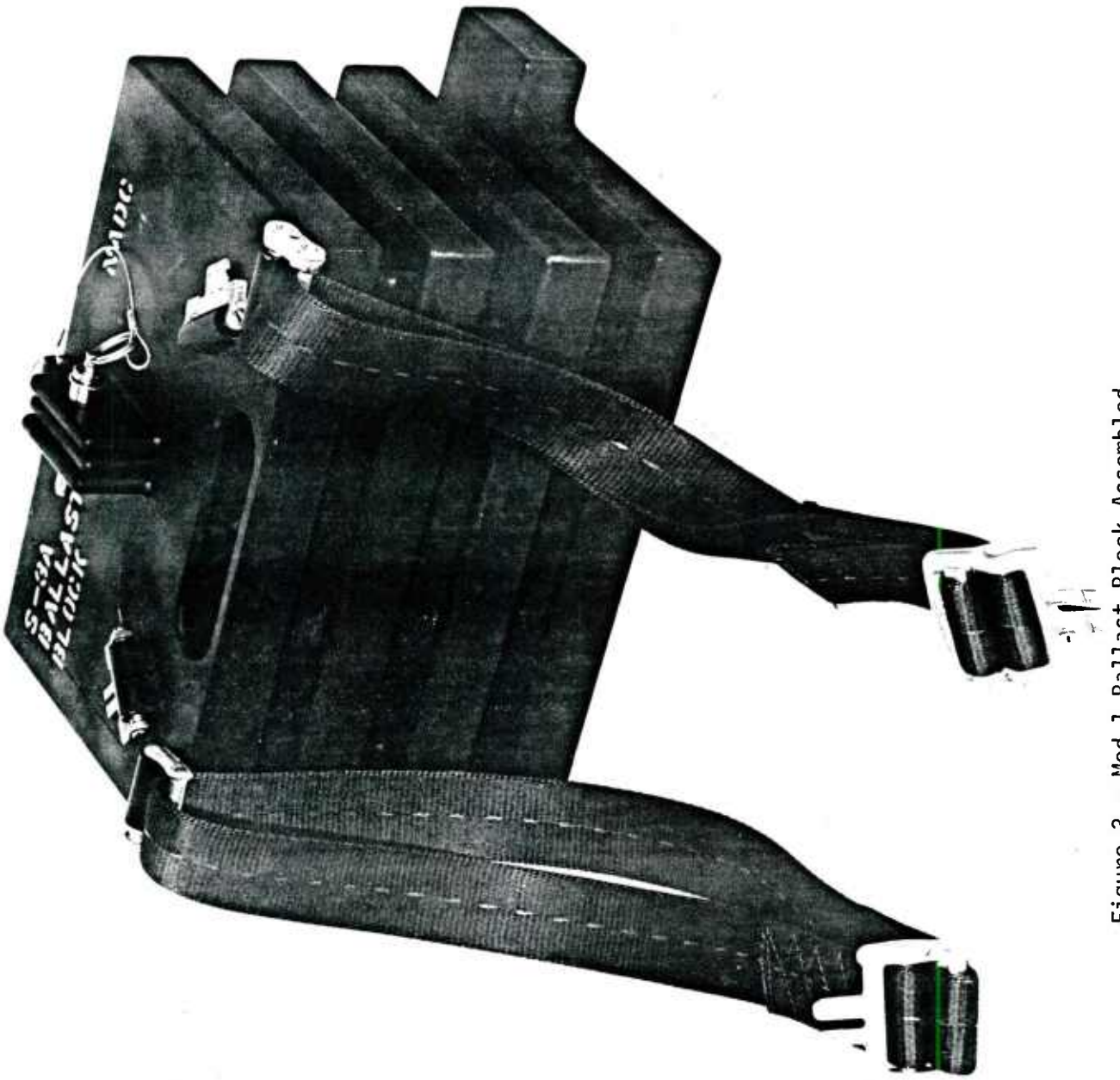



Figure 3 - Mod 1 Ballast Block Assembled

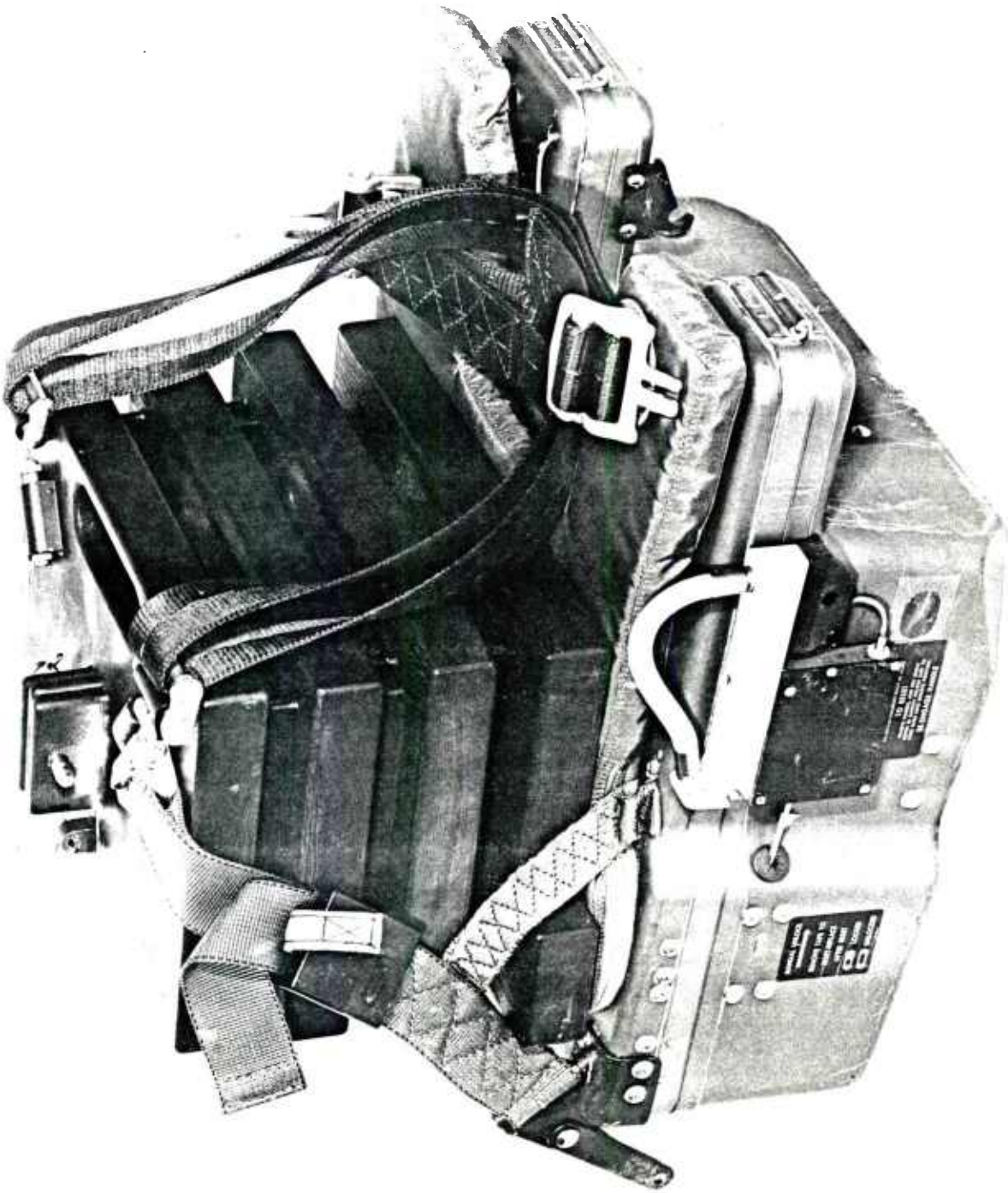


Figure 4 - Ballast Block Mounted On Survival Kit

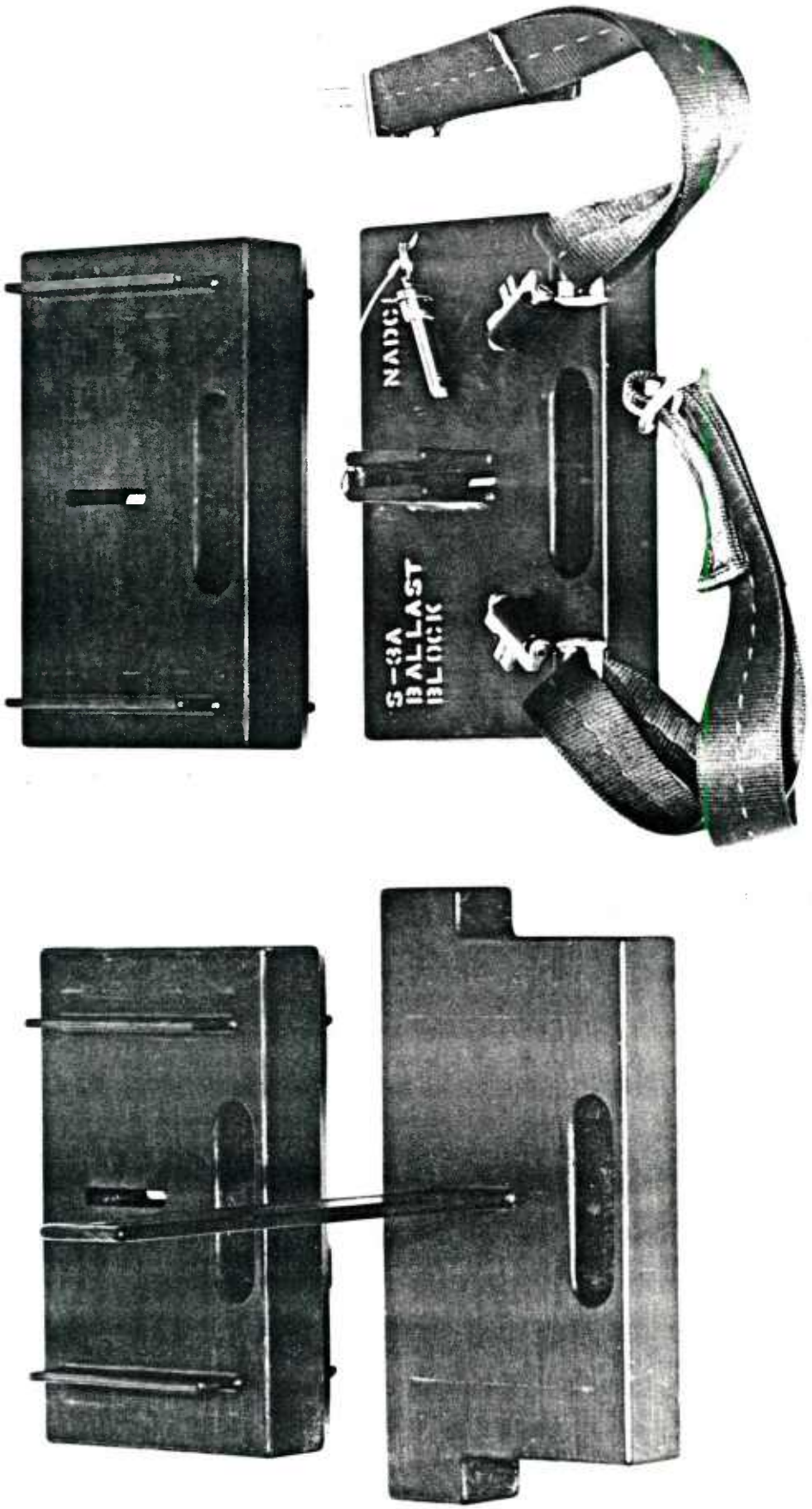



Figure 5 - Mod 1 Ballast Block Disassembled

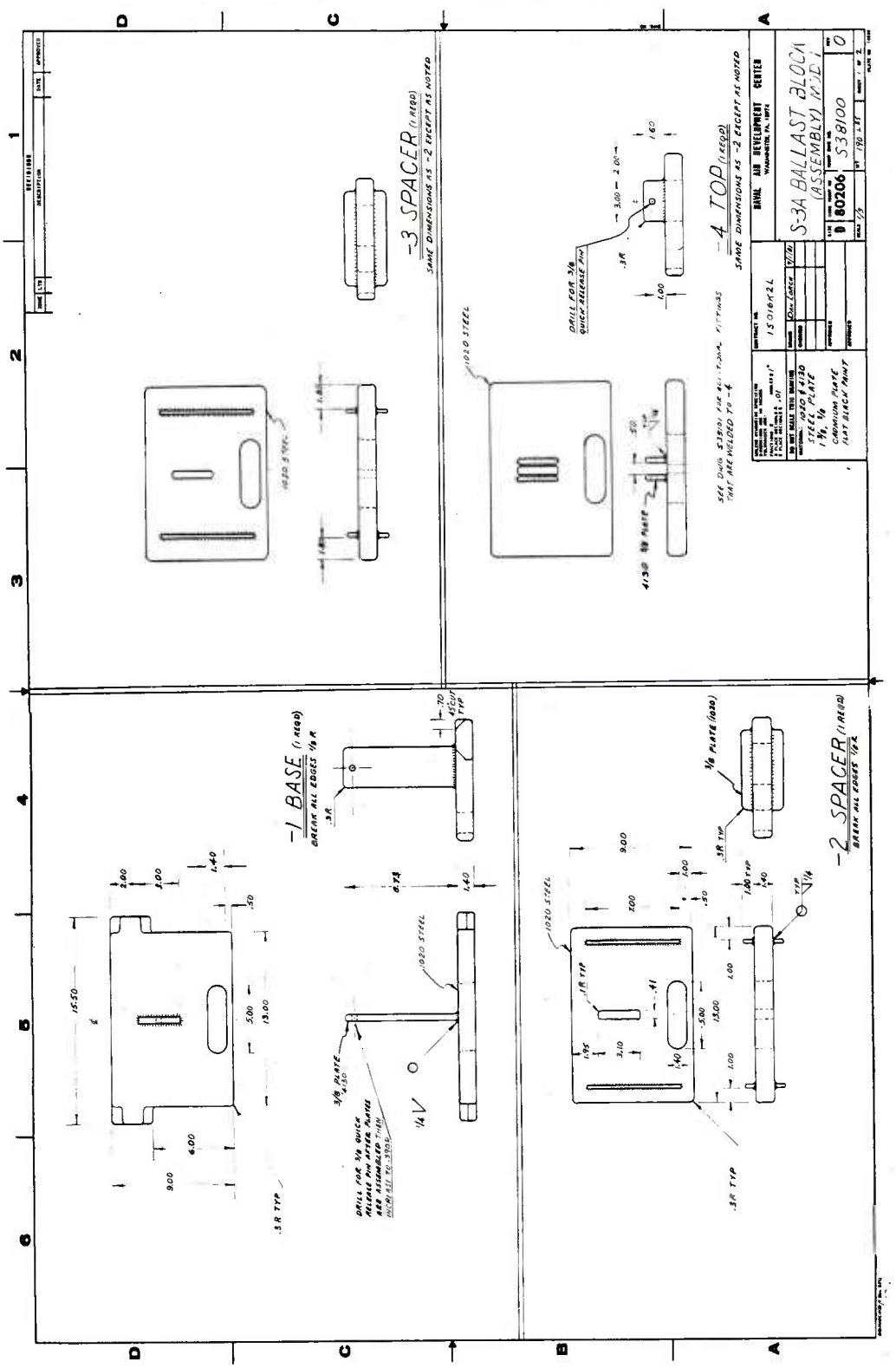



Figure 6 - S-3A Ballast Block (Assembly) Mod 1

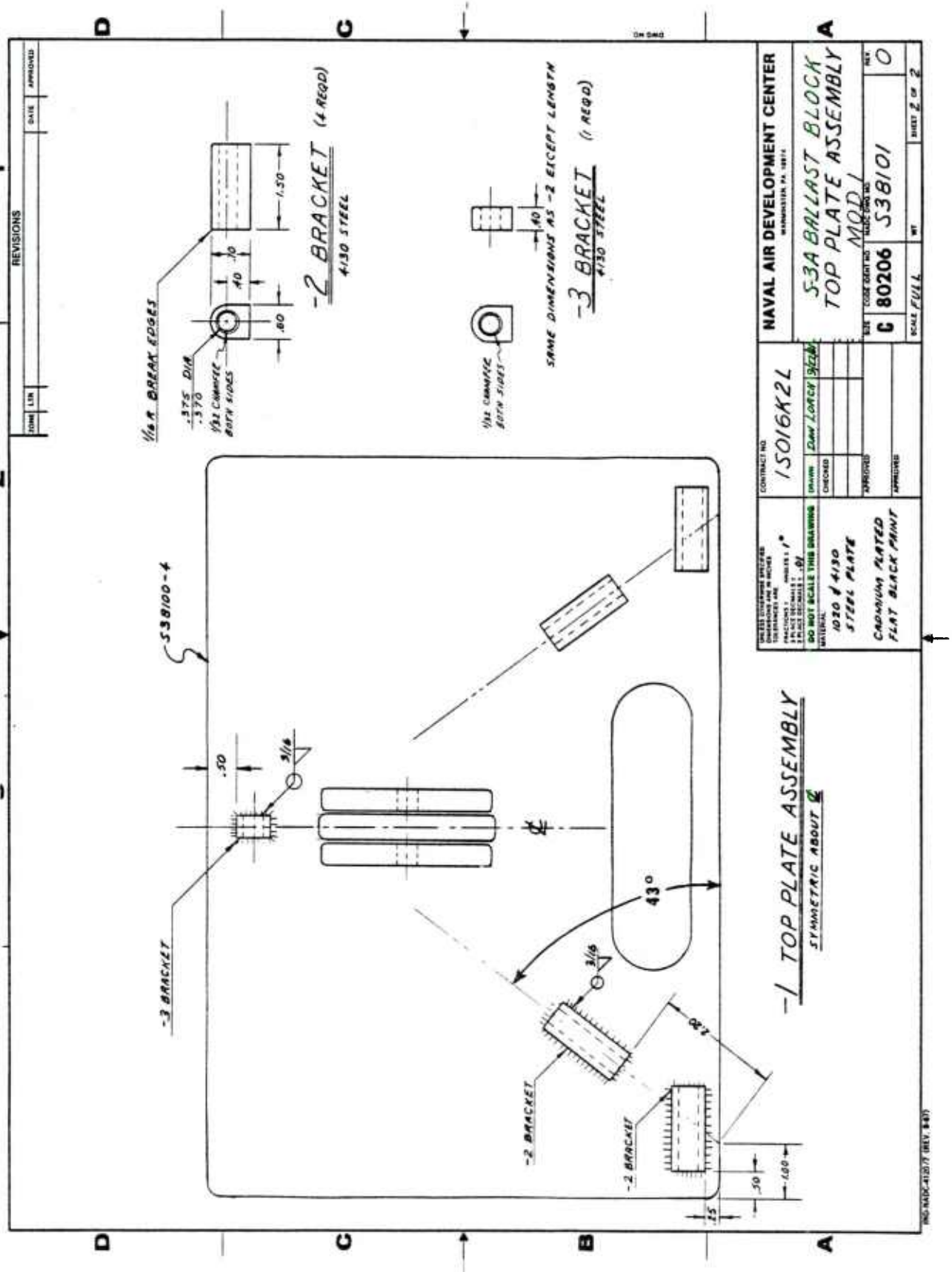



Figure 7 - S-3A Ballast Block Top Plate Assembly Mod 1

# C E N T E R  O F  G R A V I T Y  D E T E R M I N A T I O N

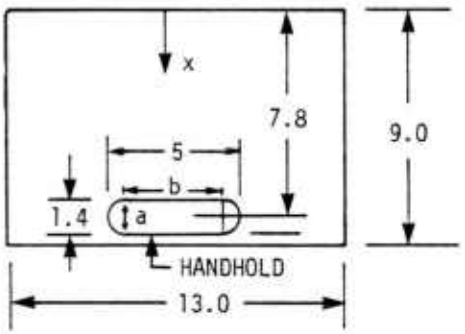
Problem:

To determine the spacing of the ballast block plates to place the seat/block center of gravity on the rocket thrust line.

Assumptions:

1. Four 45 lb plates will be used for ease of handling; the basic plate size will be 1 3/8" x 9" x 13" so it will fit on a RSSK 8 seat kit.
2. The configuration of the block was designed first; this will establish the x location of the block center of gravity. Then the spacing of the four plates will be determined to raise the seat/block center of gravity onto the rocket thrust line.

1 3/8" Plate $w = .39\ lb/in.^2$




All x distances measured from back edge of plate.

Full Plate (No Handhold)

$W = w \times A = .39\ lb/in.^2 \times 9\ in. \times 13\ in.$
$w = 45.6\ lb.$
$x = 9/2 = 4.5\ in.$

Handhold Cutout

$$A = a \times b + \frac{\pi a^2}{4}$$

$$A = 1.4 \times 3.6 + \frac{\pi(1.4)^2}{4}$$

$$A = 5.04 + 1.53 = 6.58\ in.^2$$

$$W = w \times A = .39\ \frac{lb.}{in.^2} \times 6.58\ in.^2$$

$W = 2.56\ lb.$

$x_c = 7.8\ in.$

Plate With Handhold

$W_p = 45.6 - 2.56 = \underline{43.0}\ lb.$

$W_p \cdot x_p = \Sigma W \cdot x$

$43\ x_p = 45.6\ (4.5) - 2.56\ (7.8)$

$$x_p = \frac{205.2 - 20.0}{43.0}$$

$x_p = \underline{4.30}\ in.$

WEIGHT 4 PLATES = 172.0 lb.

(See Figure 8 For Completion Of Study)

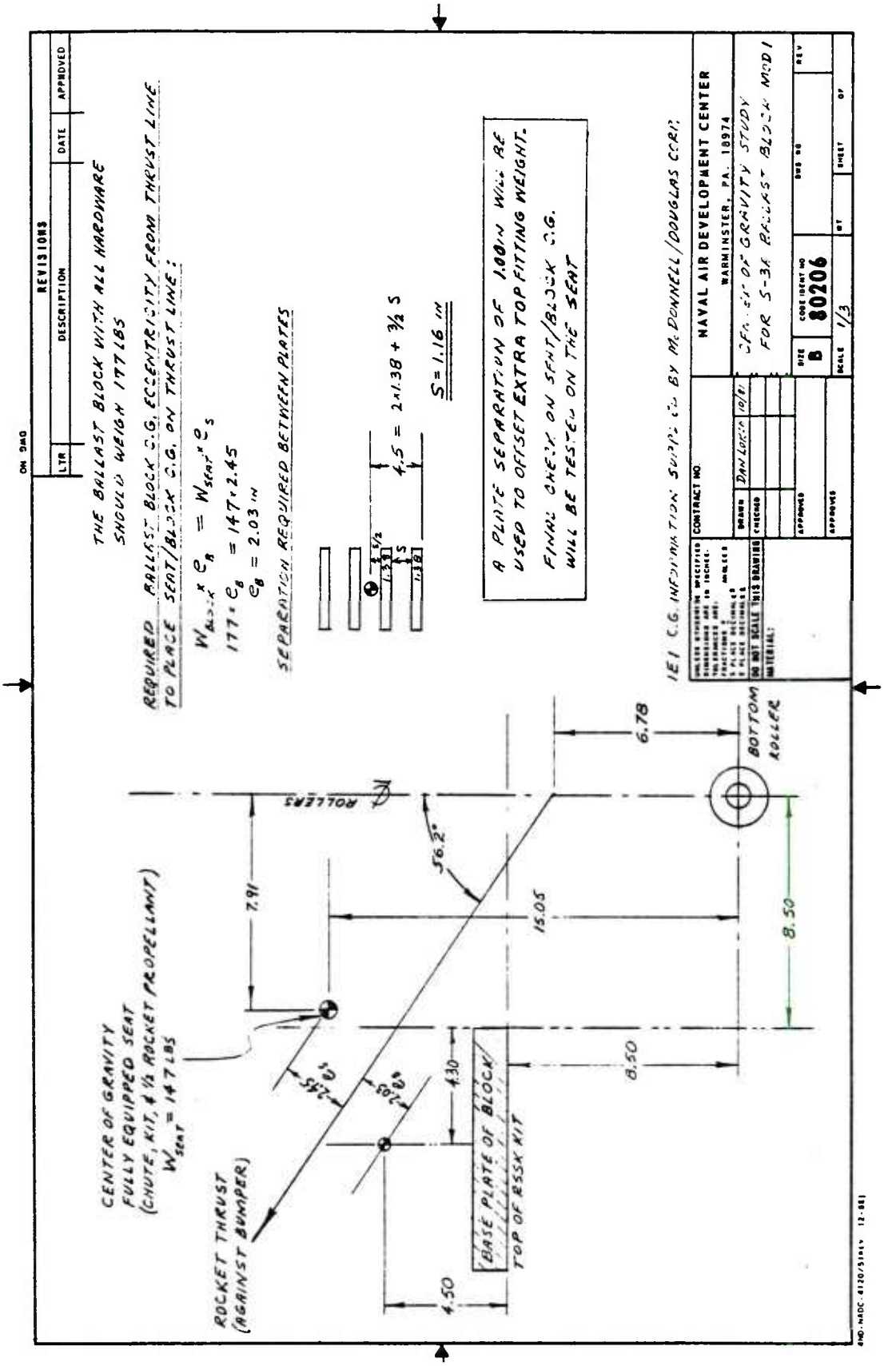



Figure 8 - Center Of Gravity Study For S-3A Ballast Block Mod 1

TABLE I - S-3A BALLAST BLOCK IMPLEMENTATION COST (30 Blocks, 10 Spares)

Number Required

12 Squadrons x 2 $\frac{\text{Blocks}}{\text{Squadron}}$ = 24
Training Squadrons = 6
Spares = 6
10% Extra = 4
40 Blocks required

Cost Per Block $\frac{81K}{40} \cong$ $2025 each

| ITEM OR SERVICE | QUANTITY | UNIT PRICE | TOTAL |
|---|---|---|---|
| SHOULDER QUICK RELEASE ADAPTER 1670-00-148-8492 | 80 | $51.00 | $4080 |
| LAP BLET QUICK RELEASE ADAPTER 1670-00-986-8334 | 80 | 38.00 | 3040 |
| LINK, PARACHUTE REMOVEABLE CONNECTOR SPEED 1670-00-461-5108 | 80 | 5.60 | 488 |
| 1 3/4" NYLON WEBBING TYPE 27 | 100 yds | .24/yd | 24 |
| QUICK RELEASE PINS | 40 | 7.17 | 287 |
| 1/8" 100 ft STAINLESS STEEL CABLE | 100 ft | 35.00 | 35 |
| STEEL FOR BALLAST BLOCKS | 40 | 200.00 | 8000 |
| LABOR & OVERHEAD 25 HOURS/UNIT x $32/HOUR | 40 | 800.00 | 32000 |
| CENTER OF GRAVITY TEST AT NAVAIRDEVCEN | 1 | 2000.00 | 2000 |
| CATAPULT & ARRESTMENT TESTS AT NAVAIRTESTCEN | 4 | 5000.00 | 5000 |
| DRAWINGS NAVAIRDEVCEN | 5 | 1500.00 | 7500 |
| LOGISTICS SUPPORT PLAN | | | 6000 |
| PUBLICATIONS PREPARATION | 3 pages | | 5000 |
| PUBLICATION PRINT & DISTRIBUTION | 3 pages | | 1500 |
| SHIPPING OF BLOCKS TO SQUADRONS | | | 4000 |
| ADDITIONAL EXPENDITURES (TESTS, EQUIPMENT, INFLATION, ENGINEERING, ETC.) | | | 2000 |
| | | TOTAL COST = | $80,954 |
| | | REQUESTED FUNDS = | $81K |

# C O N C L U S I O N S

1. The second prototype (Mod 1) S-3A Ballast Block appears to meet all requirements for center of gravity location, ease of handling, and low maintenance.

2. The total implementation cost for 40 Ballast Blocks will be $81K.

3. Additional center of gravity tests at NAVAIRDEVCEN, and several catapult and arrestment tests by the Naval Air Test Center will be required before the blocks can be accepted for service in the S-3A aircraft.